Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing (FFL) – An Observational study

By,

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Dissertation Submitted to the

Odisha University of Health Sciences, Bhubaneswar, Odisha

In partial fulfilment of the requirements for the degree of

MASTER OF PHYSIOTHERAPY (M.P.T) In

SPORTS PHYSIOTHERAPY

Under the guidance of

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ABHINAV BINDRA SPORTS MEDICINE & RESEARCH INSTITUTE

Bhubaneswar, Odisha

2023-2025

Odisha University of Health Sciences

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "Correlation **between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing (FFL) - A observational study**" is a Bonafide and genuine research work carried out by me under the guidance of **Dr. Asifuzzaman Shahriyar Ahmed(PT)** ASSOCIATE PROFESSOR of ABSMARI, BBSR

Date:

Place: Bhubaneswar

Signature of the Candidate

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled "Correlation **between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing (FFL) - A observational study**" is a bonafide research work done by Mr. Sumukh N Pandith in partial fulfillment of the requirement for the degree of Master of physiotherapy Physiotherapy in Sports Medicine and Rehabilitation.

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ENDORSEMENT BY THE HEAD OF DEPARTMENT

This is to certify that the dissertation entitled **"Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing(FFL) – An Observational study"** is a bonafide research work done by **Sumukh N Pandith** under the guidance of **Dr. Asifuzzaman Shahriyar Ahmed(PT), Associate Professor** of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar.

Date: Seal & Signature of the HOD

Place: **Dr. Asifuzzaman Shahriyar Ahmed (PT)**

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ENDORSEMENT BY THE PRINCIPAL

I hereby declare that this dissertation entitled "Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing(FFL) observational study " is a Bonafide and genuine research work carried out by me under the guidance of **Dr. Asifuzzaman Shahriyar Ahmed(PT)**, Associate Professor of ABSMARI, BBSR

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CERTIFICATE OF ACCEPTANCE

This is to certify that the dissertation entitled: "**Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing(FFL) – An Observational study "** carried out by **Mr. Sumukh N Pandith** bearing University Registration Number 23MP435052 has been **evaluated and accepted by me as an Examiner / Evaluator,** appointed by the **Odisha University of Health Sciences, Bhubaneswar,** in partial fulfilment of the requirements for the award of the degree of **Master of Physiotherapy in Sports.**

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I, **Sumukh N Pandith** student of Abhinav Bindra Sports Medicine and Research Institute, hereby declare that the Odisha University of Health Sciences and Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha shall have the perpetual rights to preserve, use, and disseminate this dissertation in print or electronic format for academic and/or research purposes.

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Place: Bhubaneswar, Odisha Sumukh N Pandith

ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to the Almighty, my family, and friends for their unwavering encouragement, understanding, and love. Their support has been a constant source of strength during this academic journey.

I extend my sincere gratitude and appreciation to the management and administration of Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar, and those who have supported and guided me throughout the journey of this dissertation. Without their valuable contributions, this work would not have been possible.

I am also immensely grateful to Dr. Chinmaya Kumar Patra, the Principal, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar. Your encouragement and belief in my abilities have been a source of motivation and confidence.

I would like to express my deepest gratitude to my dissertation guide, Dr. Asifuzzaman Shahriyar Ahmed, Associate Professor. Abhinav Bindra Sports Medicine and Research Institute, Bhubaneshwar. Your unwavering support, expert guidance, and insightful feedback have been instrumental in shaping this research. Your dedication to excellence in academia has inspired me to strive for higher goals in my academic pursuits.

Furthermore, I would like to extend special thanks to Dr. Deepak Pradhan for their valuable assistance and support throughout this research. Your expertise and constructive criticism have helped me refine my work and explore new dimensions in my study. I am also thankful to all the faculty members, staff, fellow students, and subjects who have contributed to my academic growth and provided a stimulating environment for learning.

In conclusion, this dissertation stands as a testament to the collaborative efforts of the individuals mentioned above, and I am deeply grateful for their contributions to my academic success.

Thank you.

Date: Signature of the Candidate

Place: Bhubaneswar **Name: Sumukh N Pandith**

List of Abbreviation

1. FFL: front foot landing
2. LTF: Lateral trunk flexion
3. mSEBT: Modified Star excursion balance test
4. ROM: Range of motion
5. SL-LESS: single leg landing error scoring system

Abstract

Background and objective: Fast bowlers are heavily exposed to the match-play work load which makes them very much prone for developing injury. The high prevalence of lumbar injury in fast bowlers is due to the number of factors such as, increased work load, increased thoraco-lumbar and lumbar extension, increased shoulder counter rotation, increased thoraco-lumbar lateral flexion, and poor pelvic-femoral stability. Objective of this study is to correlate lateral trunk flexion with the other predictive factors of the spine.

Methods: The articles were explored with appropriate keywords under relevant sections. The literature search was conducted from electronic databases PubMed and Google Scholar. The samples were selected on the basis of the inclusion criteria and a total of 45 samples were selected and examined for the research.

Result: The overall analysis showed that the variables are not statistically significant, $F(8,36)= 1.242$, $p = 0.304$, indicating that the combination of all the predictors did not show variance in the outcome variable. There was a total of 21.6% of variance in the dependent variables($R^2 = 0.216$) with the multiple correlation coefficient of $R = 0.465$.

Conclusion: This study found that the predictors, hip internal rotation ROM, shoulder internal rotation ROM, latissimus dorsi muscle length, trunk rotation ROM.sprint performance, drop landing, and the mSEBT did not significantly predict the LTF in amateur fast bowlers.

Keywords:

Fast bowlers, Spine injury, Lateral trunk flexion, and flexibility

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INTRODUCTION

Introduction:

In the game of cricket there will be different roles, such as batting, bowling, wicketkeeping and fielding. Each of these roles has its own form of specific movements and different physiological and functional needs to which players should adapt to excel. Among all these roles the fast bowling is more dynamic, energy consuming and has high physiological demands[1]. Fast bowling mainly consists of 4 different bowling actions, that is front-on, side-on, semi-open and mixed bowling. Different fast bowlers adapt or learn different bowling actions which is suitable for their body structure[2]. Fast bowlers are one who have the most energy demanding actions in the cricket and therefore, has the shortest cricketing career. A typical fast bowler bowling 10 overs will cover up to 1.9km with discontinuous bowling activity and therefore should have higher fitness levels and should follow proper injury prevention protocols, as they are more prone to develop back injury due to the repeated lateral trunk flexion during front foot landing[3].

Fast bowlers are heavily exposed to the match-play work load which makes them very much prone for developing injury. Study says that the workload of the fast bowlers has direct relationship with the injury and performance. Therefore, fast bowlers depend on number of components to prevent themselves form the injury[4].

As the fast bowlers has high physiological demands, they are more prone for the injuries as well. The most common injuries were to the knee (41%) and lower back (37%), followed by 'other' (16%) and shoulder injuries (16%). The 'other' injury group included injuries to areas such as the groin, face, heel, toes, stomach, and wrist[5]. During the delivery stride there are more stresses placed over the lumbar spine, 86%of fast bowlers were seen to have pars interarticularis injury on the non-dominant side. The prevalence of lumbar disc degeneration in fast-bowlers ranges from 21-65% with

an incidence rate of 15% per year[6]. The bowlers who underwent back injuries where more reported in mixed action fast bowlers. The increased shoulder separation angle during back foot contact, increased shoulder counter-rotation, larger hip angles and straight knee during front foot contact all increased the risk of developing the stress fractures in the back[7].

The high prevalence of lumbar injury in fast bowlers is due to the number of factors such as, increased work load, increased thoraco-lumbar and lumbar extension, increased shoulder counter rotation, increased thoraco-lumbar lateral flexion, and poor pelvi-femoral stability[8]. Along with these factors the upper trunk flexion along with the delayed upper arm and high ball release during front foot landing will cause higher ball release speed in male fast bowlers. This upper trunk flexion will help in conversion of linear momentum(run up) to the angular momentum along with a large amount of forces action on body leading to more prone for a fast bowler for injury. When compared with the female fast bowlers the male fast bowler will not convert the linear momentum into angular momentum effectively which leads to lower ball release speed and lower force production, therefore the body will be under less stress in females. Hence male fast bowlers are more prone for the injury than female fast bowlers[9].

Each individual bowler is likely to have an optimum run-up speed, beyond which ball velocity and accuracy are compromised. A fast bowler with increasing their maximum run-up velocity and maximum velocity during delivery stride by 1m/s will result in the ball being delivered approximately 1km/h faster[10].

Shoulder muscles flexibility is one of the risk factors for causing stress fractures in the lumbar spine. Greater internal rotation, decreased external rotation, and increased total arc of rotation were associated with technique characteristics linked with increased ball release speed and reduced lumbar stress injury risk[11]. The bowlers who released

the ball higher had an history of back injury when compared to bowlers without any back injury. Similarly, higher hip angles were general characteristics of those bowlers who suffered a stress fracture[12].

Need of the study

Need of the study:

By synthesizing the researches, we understood that, there is no single cause but rather a combination of factors which will predispose fast bowlers to injury. The above-mentioned causes are some of the main components which will cause lateral trunk flexion and lead to injury to the lumbar spine in fast bowlers during the front foot landing (FFL). The time spent on the back foot is less compared to front foot in a delivery stride, so the force production will be high during the FFl when compared to back foot landing (BFL). This increase in force production during the FFL might. predispose the fast bowler to develop injuries in various parts of the body. Therefore, there is high need for this study to be conducted.

Aim and Objective of the study

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Aim of the study:

the aim of the study is to assess the relation between the lateral trunk flexion and associated risk factors of the spine during the front foot contact of fast bowling.

Objective of the study:

To correlate,

Increase in runup speed and LTF in fast bowlers

Single leg drop landing and LTF

SEBT differences and LTF

Hip internal rotation, shoulder internal rotation, trunk rotation difference and LTF

Latissimus

dorsi muscle tightness and LTF

HYPOTHESIS

Ho: There is no significant correlation between lateral trunk flexion and associated risk factors of spine

HA: There is significant correlation between lateral trunk flexion and associated risk factors of spine

Review of literature

Methodology of literature review:

The articles were explored with appropriate keywords under relevant sections. The literature search was conducted from electronic databases PubMed and Google Scholar. Keywords included were selected for individual section with or without using Boolean operator AND, IN. The databases used were PubMed and Google scholar. The search was then narrowed by adding keywords. Articles other than the English language and human trials were excluded. The narrowed article titles and abstracts were screened. Excluded articles with quality less than 60% in JBI critical appraisal tools. The outcomes of the review are described in the following pages under the relevant section. Based of the available articles the literature review was divided into three sections.

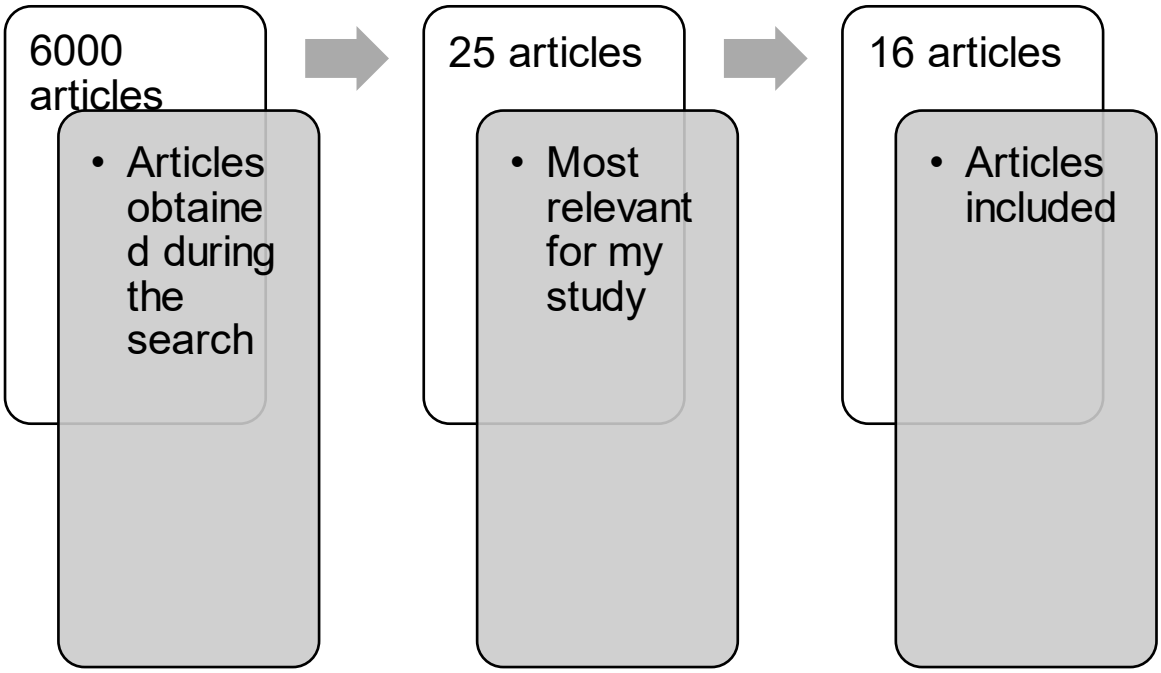
Section 1: to find correlation between lateral trunk flexion (LTF) and risk factors for spine in fast bowlers

Section 2: to find the most valid tests to assess the risk factors

Section 3: methods to evaluate the LTF

Key words:

Fast bowling, Actions, lumbar, injury, lateral trunk flexion, Shoulder flexibility, SEBT, Single leg drop landing, Biomechanics, Analysis, ROM, differences.


6000 articles
• Articles obtained during the search
25 articles
• Most relevant for my study
16 articles
• Articles included

Section 1: To find correlation between lateral trunk flexion(LTF) and risk factors for spine in fast bowlers

Helen Baynea, et al. In their study stated that extreme trunk lateral flexion postures are frequently seen in fast bowlers during the delivery stride. It has been suggested that this action places a great amount of stress on the lumbar spine and is the reason why low back injuries, especially lumbar bone stress injuries, are so common in this population[24].

Etsuo Chosa, et al. Explained in their study that under compression alone, the pars interarticularis experienced the least amount of stress; however, when compression was combined with flexion, rotation, and extension, as well as lateral bending loading, the stress increased. Particularly with extension and rotation, the parsinterarticularis experienced substantial stress, which led to the suggestion that those loadings constituted relatively high risk factors for spondylolysis[25].

Akira Saito, et al. In their study concluded that the lateral trunk flexion and extension position of trunk during the single leg landing will increase the risk of developing the injuries[26]

Inference:

By reading above articles we can conclude that the lateral trunk flexion happens prominently in mixed-on action bowlers and is a major risk of injury for the spine. The

stress in the pars interarticularis is increased even more when the lateral trunk flexion is combined with the flexion, rotation and extension.

Along with the lateral trunk flexion the hyperextension in the lumbar spine is the increased risk of injury to the spine and the knee.

2: To find the most valid tests to assess the risk factors

V B Vad, et al. conclude that there is a relationship between the HIRD with LBP and decreased GIRD with shoulder pain. This study also shows strong relation between the HIRD, GIRD and low back pain. In support to this Jácome-López, et al. found that there is a strong correlation between the GIRD and shoulder pain[27].

James A. Johnstone, et al. In their study stated that Variations in the bowler's run-up speed, distance travelled, and bowling action can all have an impact on delivery speed. Run up speed may have an impact on release speed of up to 16%, and run up length has been linked to the delivery's mean speed. In continuation for this Peter J.

Worthington, et al. Concluded that the fast bowlers with a quicker run-up, maintain a straighter knee throughout the front foot contact phase, have larger amounts of upper trunk flexion up to ball release and appear to delay the onset of arm circumduction[28].

Samuel J. Callaghan, et al. In their study stated that reduced vertical GRF indicates improved performance in both single- an double-leg drop landings, which would indicate a better capacity to appropriately reduce the high forces during landing. During front foot landing there is high forces placed on pelvis and lower limb[29].

B. Olivier a, et al. Used SEBT to find the lumbo-pelvic movement control and concluded that the star excursion balance test can be used to predict the risk of back injury in fast bowlers as the SEBT assess the pelvi-femoral stability.

D. Foster, et al. In their study found that shoulder depression and horizontal flexion strength for the preferred limb were significantly related to back injuries in fast bowlers. Additionally, the study highlights the importance of considering shoulder flexibility and strength as part of the biomechanical factors that may contribute to back injuries in this population[30].

Inference:

By reading the above articles we can conclude that, during the run-up the speed of the run-up contributes to the increased in the ball release speed. More the ball release speed more the efforts required during the front foot landing in fast bowlers.

The pelvi-femoral stability plays an important role in stabilizing the lumbar region during the FFL, so the SEBT is more appropriate way of assessing the pelvi-femoral stability. Similarly, the single leg drop landing test will help in assessing the pelvis and lower limb stability during front foot landing.

The HIRD and GIRD are another component which can cause the LBP in the sports which involves the rotation of trunk and hip rotation motions.

The shoulder horizontal flexion and depression tightness and strength has a role in causing the LBP in the individuals.

Section 3: Methods to evaluate the LTF

Craig A. Ranson, et al. In their Methodology they used a 3-D analysis was conducted using 12 camera Vicon Motion Analysis System (Oxford, UK) operating at 120 Hz was used to capture a lower trunk range of motion (ROM) trial and six fast bowling trials for each bowler[31].

Daniel Cottam, et al. Wanted to see the difference between the 2D and 3D assessment in fast bowlers. They concluded that Overall, the 2D measurements correlated strongly with the 3-D kinematic Measurements[32].

Inference:

Usually, to analyse the action of the fast bowling 3-D camera set-up is required, but to assess the lateral trunk flexion during the FFL the 2-D camera showed the same result as 3-D camera. So the 2-D camera system can be used for the analysis of the lateral trunk flexion during FFL of fast bowlers

Methodology and Procedure

Methodology

Study design: Observational study

Study population: Amateur fast bowlers

Sampling technique: Convenient Sampling

Sample size: 51 calculated using G-Power software by altering the r^2 value.

Study setting: Cricket academies in Bhubaneshwar

Study duration: 1 year

Participant characteristics:

Inclusion criteria

Amateur fast bowlers who should be practicing cricket since 8 months

Only males are included

Age 18-25 years old

Exclusion criteria

Fast bowlers with recent injuries

part-time bowlers

Spin bowlers

Fast bowlers who cannot bowl with full potential due to any discomfort

Outcome measures:

Star excursion balance test(SEBT)

Single leg drop landing test

Muscle length testing

Range of motion

Procedure

Procedure:

Approval from the IRC

Permission from the college for equipment

Selecting the subject based on inclusion criteria

Explaining the procedure and method and signing the consent form

Preparation of participants

Data collection

Data analysis

Result and conclusion

Preparation of participants:

Consent form sign

Warm up

Demonstration of tests by investigator

Trials of the tests

Modified Star excursion balance test:

The test will be performed, with participants standing in the middle of a grid with 8-mm lines extending at 45 angles from the centre of the grid.

The heel of the participant's stance foot was aligned with the centre of the grid, and his big toe was aligned with the anterior line. The participant was asked to reach with his reaching leg as far as possible along the 4 diagonal directions. He had to make a light touch on the line and return to the centre while maintaining a single-leg stance with the opposite leg in the centre of the grid and keeping his hands on his waist. Standard tape measures were placed on the grid lines to quantify the distance (centimetres) that each participant reached. Three consecutive repetitions were made in each direction in the following order

Figure 1: Modified Star excursion balance test

Single leg drop landing test:

The players were asked to hop from an aerobic step of 10-50 cm height on a single leg. They kept all movement to a minimum standing on the testing leg for 15 s, while keeping their hands on the iliac crest. Players were instructed to look at a visual target 4 m ahead on a blank wall.

Figure 2: Single leg drop landing

Muscle length testing:

Latissimus dorsi:

Starting position: the patient will be in supine position and is asked to flex his testing shoulder as much as he can.

Testing procedure: the fulcrum of goniometer is placed on the lateral aspect of acromion process and the stable arm should be placed parallel to the thoracic cage and moveable arm is parallel to shaft of humerus.

Range of motion:

Hip rotations:

AXIS LOCATION	STATIONAY ARM	MOVEMET ARM
mid patella	perpendicular to the floor	parallel to long axis of the tibia

Shoulder rotations:

AXIS LOCATION	STATIONARY ARM	MOVEMENT ARM
olecranon process of the ulna	perpendicular to the floor (vertical)	in line with the ulnar side of the forearm from the axis point to the ulnar styloid process

Trunk rotation:

Testing position: place subject in in sitting without back support, with feet on the floor to help stabilize the pelvis.

Stabilization: stabilize the pelvis to prevent rotation, and than ask the subject to rotate to one side as far as possible.

Procedure: place the fulcrum of the goniometer on the centre of the head and place the stable and movable arm in parallel to AC joint.

30-M Dash:

The evaluator place 2 markers 30 meters apart and the participant will start to run on the signal of GO and will run as fast as possible till the end cone. The timing wills be noted.

Figure 3: 30-m Dash

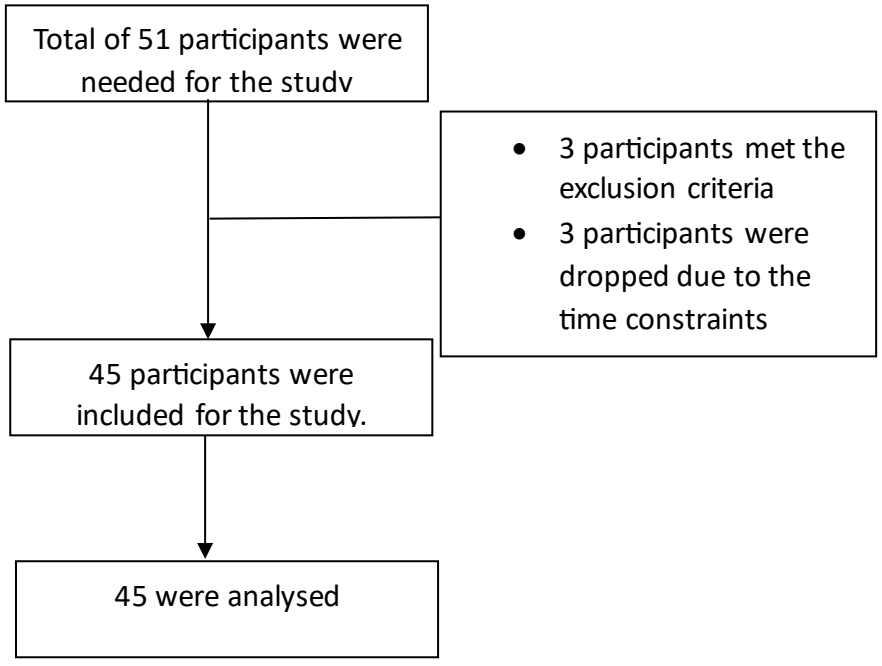
Lateral trunk flexion:

A camera is placed posteriorly 16m far from the popping crease just behind the bowler.

The bowler is asked to bowl with his full potential and the video will be recorded in the camera

Figure 4: lateral trunk flexion

METHODLOGY FLOW CHART:



Statistical Analysis:

Statistical analysis was performed using IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp. Normality of the data was found using Shapiro Wilk. Descriptive analysis was done using mean and standard deviation.

Results

Results:

A total of 45 amateur fast bowlers met the inclusion criteria in which the mean age was 21.8+/- 0.31, mean height was 173.3+/- 0.66 and the mean weight was 69.02+/- 1.05 as shown in (table 2). Additionally, the mean of lateral trunk flexion is 45.91+/- 7.50, mean of SL-LESS is 1.77 +/- 0.59, mean of modified SEBT is 80.98 +/- 7.83, mean of 30-M dash is 5.23 +/- 4.77, mean of hip internal rotation is 20.66 +/- 4.77, mean of shoulder internal rotation is 40.04 +/- 13.25, mean of trunk rotation(right) is 78.91 +/- 6.36, mean of trunk rotation(left) is 78.82 +/- 8.85, and the mean of latissimus dorsi muscle length is 163.3 +/- 8.34 as shown in (table 3). As the sample size is greater than 30 the Shapiro Wilk test was used to testing the normality, whose value is 0.56. This indicates that the data is normally distributed as shown in (table 1).

Variables	*P* value
Age	0.55
Height	0.56
Weight	0.52

Table 1: Normality distribution

Variables	Mean	Standard deviation
Age	110	103
Height	223	214
Weight	197	120

Table 2: Descriptive statistics

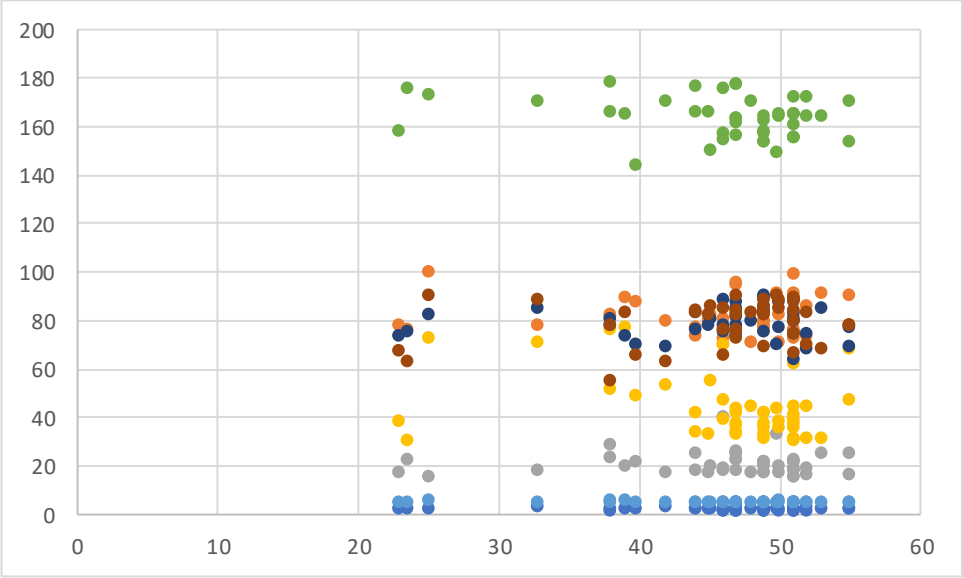
To find the relationship between the variables, multiple regression analysis was conducted as there are eight independent variables and a single dependent variable. The overall analysis showed that the variables are not statistically significant, $F(8,36)= 1.242$, $p = 0.304$, indicating that the combination of all the predictors did not show variance in the outcome variable. There was a total of 21.6% of variance in the dependent variables($R^2 = 0.216$) with the multiple correlation coefficient of $R = 0.465$. This indicates a moderate degree of association between the predictors and the outcome. Additionally, the analysis also found that the confidence interval for the latissimus dorsi muscle length is broader with $B = 0.152$

Variables	Mean	Standard Deviation
Lateral Trunk flexion	45.91	7.50
SL-LESS	1.77	0.59
Modified SEBT	80.98	7.83
30-M Dash	5.23	4.77
Hip Internal rotation	20.66	4.77
Shoulder Internal rotation	44.04	13.25
Trunk rotation(right)	78.91	6.36
Trunk rotation(Left)	78.82	8.85
Latissimus dorsi muscle length	163.3	8.34

Table 3: Variable's characteristics(SL-LESS: single leg landing error scoring system, SEBT: Star excursion balance test)

Model	R^2	R	F
1	0.216	0.465	1.242

Table 4: Summary of Multiple Regression Analysis



Graph 1: Multiple Regression Visual representation

Discussion

Discussion:

The present study evaluated the relation between the lateral trunk flexion (LTF) with the multiple other predictors of the spine injury, such as hip internal rotation range of motion(ROM), shoulder internal rotation ROM, trunk rotation ROM, latissimus dorsi muscle length, sprint performance, drop landing using the single length landing error scoring system, and the modified star excursion balance test(mSEBT). As there is single dependent and multiple independent variables, a multiple regression analysis was conducted, which revealed that the overall model was not statistically significant, as it accounted for only 21.6% of the variance in lateral trunk flexion. Additionally, there was moderate correlation between the predictors and the LTF and latissimus dorsi muscle length showed broader confidence interval.

Previous research has highlighted that the trunk acts as the core for in the kinetic chain, suggesting that deficits in proximal stability or mobility will cause distal dysfunction. Additionally, researches have found that decrease in the hip ROM causes low back pain[22,23]. These findings imply a stronger connection between hip ROM and trunk function. Further studies again suggested that the trunk movement is highly associated with the dynamic control of the pelvis[14].

When evaluating regression between the variables there was no significant variance but the correlation showed moderate correlation which existed between some variables with the LTF, which indicates that there might be one-fifth of variance in LTF. This suggest that these factors may still have some role, but other unmeasured variables such as neuromuscular control, spine mobility, and core activation likely accounts for greater share of variance[13,14]. Additionally, it is important to know that the lateral trunk flexion is not an isolated movement but is a multi-joint and multiplanar movement which requires coordinated action of the lumbar spine, thoracic spine,

pelvis, and surrounding muscles[15]. Therefore, it is not adequate to explain the association with isolated joint ROM or other performance metrics.

When considering biomechanical perspective, the LTF requires various components such as mobility and stability. In this study some of the mobility and stability components are added such as the hip, shoulder Internal rotation ROM, and the trunk rotation ROM along with the latissimus dorsi muscle length as decreased length might decrease the mobility of the shoulder. Along with these the stability components are drop landing and mSEBT. These components were added as predictors as restriction in these motions are thought to lead to compensatory trunk movements[16]. In a study they showed that limited hip internal rotation is associated with altered trunk lean during the cutting and sprinting tasks[17]. However, this study did not find a support a predictive role of hip ROM in explaining the trunk lateral flexion.

One of the possible explanations is that the lateral trunk flexion will not only depend on the ROM but mostly depends on the neuromuscular control as well. Few studies have found that the trunk motion during the athletic tasks is regulated by anticipatory muscle activation and dynamic stabilization rather than the ROM[18,19]. Therefore, the inclusion of the ROM testing outcomes may have overlooked the more influential neuromuscular contributors. Additionally, the inclusion of the latissimus dorsi muscle length was based on its role in influencing the thoracolumbar fascia tension, thoracic mobility and mainly as it is a strong glenohumeral depressor and internal rotator whose tightness might reduce the GH joint mobility[20]. In this study we found that the isolated muscle length of latissimus dorsi have no much significance, rather it might interact with other muscles such as quadratus lumborum, obliques, and erector spinae[13].

Sprint performance, drop landing, and the mSEBT were included as functional performance measures that might reflect an athlete's ability to coordinate trunk and

limb motion. Previous studies have demonstrated that trunk stability will influence the lower limb biomechanics during landing and cutting tasks[19.20]. reduced trunk stability and balance is said to have influence of developing injury and will hamper the functional performance[20,21]. The sprint performance is in sagittal plane which will align with hip, knee and ankle rather with the lateral trunk flexion which is in frontal plane[22]. Despite these evidences, the present study findings suggest that these factors were not significant predictors of the LTF. Therefore, we can state that to predict such multiplanar motions we should use functional tests which is more relevant rather than isolated testing of components.

Another relevant study emphasized the importance of core endurance and control rather than flexibility in determining the trunk performance. This study also examined the predictors of the low back pain or athletic injury also suggesting that dynamic control is more relevant than the static ROM[13,19].

By this we can understand the complexity of the risk factors which causes injury in fast bowlers, even though multiple predictors were evaluated in this research none of them showed variance with the LTF. As fast bowlers are more prone for developing low back pain during the front foot landing during the bowling task for which the later trunk flexion is one of the major risk factors for developing low back pain. Thus, by this research we can state that, during the clinical assessment of the fast bowlers for the lateral trunk flexion the clinician should not limit himself from assessing just the ROM, performance and balance components. Instead, comprehensive trunk assessment should include both the flexibility and the dynamic control measures, which is said to be one of the important components. Rehabilitation programs aimed at optimizing trunk function should therefore integrate mobility training with core strength, endurance, and proprioceptive training[23]. From a performance stand point,

the sprinting or landing mechanics does not directly influence LTF, but trunk stability during the front foot landing in bowling play's vital role in force transfer and for injury prevention. Injury prevention because as the LTF angle increases the contralateral side muscle under goes for lengthening, this repeated eccentric loading will lead to injury if not trained accordingly. By this research we understand the need for assessing more than just ROM and flexibility to assess the cause for LTF for the amateur fast bowlers during the front foot contact.

Conclusion

Conclusion:

This study found that the predictors, hip internal rotation ROM, shoulder internal rotation ROM, latissimus dorsi muscle length, trunk rotation ROM, sprint performance, drop landing, and the mSEBT did not significantly predict the LTF in amateur fast bowlers. The findings from this study emphasize that the later trunk flexion is not only caused by isolated predictors that are taken in this study. This result provides us the information about the complexity of the trunk movement assessment. This study also provides us with the importance of the trunk movement and stability in preventing the injury and to promote the performance.

Limitations and recommendation for future study

Limitations:

Our study have some of the limitations such as, the accuracy of the measuring tools as they are subject to inter-rater reliability[24], specificity of the outcome such as we have evaluated the LTF isolated but the LTF is a multiplanar motion and requires 3-D analysis, small sample size which is subjected to the underpowered to detect smaller effects, this small sample size along with multiple regression analysis will subject to the type II error, and the study design, a longitudinal study will give better results for this kind of research.

Future research:

Further studies should be conducted by keeping few things in mind, conduct the study in larger sample size, the predictors and the outcomes should be dynamic measures such as 3-D analysis rather than static or isolated such as ROM and muscle length testing, inclusion of the different components such as neuromuscular control or endurance tests, conducting an longitudinal study which is more accurate in generating results for such kind of studies, and a sports specific cohorts as the trunk movement is very much essential for different sprots

Summary

Summary:

The present study was conducted to evaluate the relationship between the LTF and the associated risk factors of spine in fast bowlers during the front foot landing. In cricket, fast bowlers are more prone for developing injury and the most predictive cause is the lateral trunk flexion. The evaluation was done on 45 amateur fast bowlers in which hip internal rotation ROM, shoulder internal rotation ROM, trunk rotation ROM, latissimus dorsi muscle length, sprint performance, mSEBT, and drop landing which was analysed with the LTF. Multiple regression analysis was conducted to evaluate the prediction of these predictors. There was only 21.6% variance of those predictors over the LTF, and there was a moderate correlation between some of the predictors with the LTF. Additionally by reviewing we came to know that the clinician should not limit themselves in assessing these predictors but should also include the neuromuscular and dynamic components as the lateral trunk flexion is multiplanar motion. This study provided us with the complexity in assessing the trunk and pelvis.

Funding statement

Funding statement:

There was no funding for this study.

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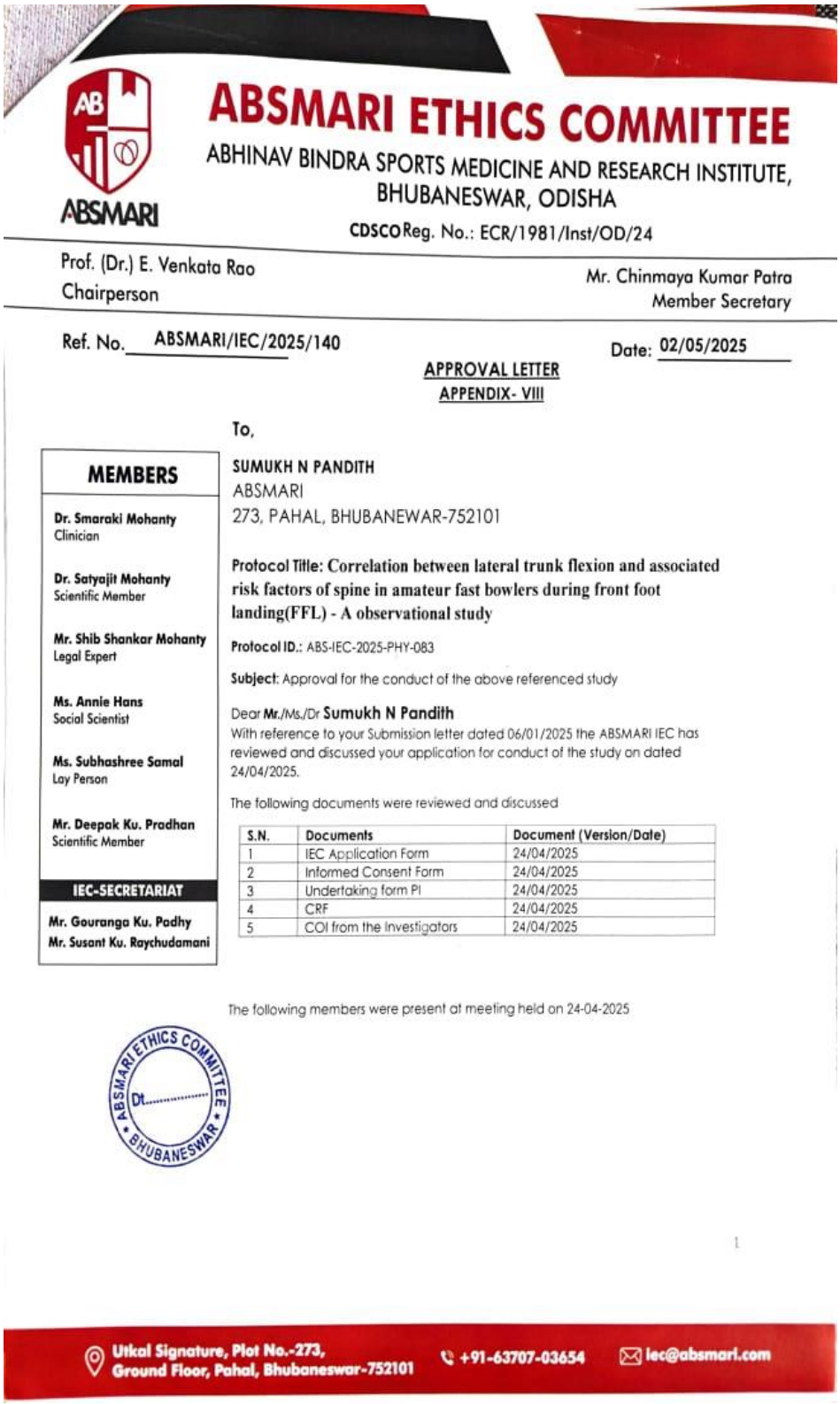
ANNEXURE

ANNEXURE A : IEC Certificate



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Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/140

Date: 02/05/2025

APPROVAL LETTER
APPENDIX- VIII

To,

SUMUKH N PANDITH
ABSMARI
273, PAHAL, BHUBANEWAR-752101

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

Protocol Title: Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing(FFL) - A observational study

Protocol ID.: ABS-IEC-2025-PHY-083

Subject: Approval for the conduct of the above referenced study

Dear **Mr./Ms./Dr Sumukh N Pandith**
With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 24/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	24/04/2025
2	Informed Consent Form	24/04/2025
3	Undertaking form PI	24/04/2025
4	CRF	24/04/2025
5	COI from the Investigators	24/04/2025

The following members were present at meeting held on 24-04-2025

ABSMARI ETHICS COMMITTEE Dt..... BHUBANESWAR

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ABSMARI ETHICS COMMITTEE

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CDSCO Reg. No.: ECR/1981/Inst/OD/24

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Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

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Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
4	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
5	Ms. Subhashree Samal	Ret. Reader-Pol Sc.	Lay Person	F	N
6	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely

Mr. Chinmaya Kumar Patra
Member Secretary
ABSMARI Ethics Committee
Pahal, Bhubaneswar

Member Secretary
ABSMARI ETHICS COMMITTEE

ABSMARI ETHICS COMMITTEE * BHUBANESWAR * Dt.

Utkal Signature, Plot No.-273, Ground Floor, Pahal, Bhubaneswar-752101 +91-63707-03654 iec@absmari.com

ANNEXURE B: Informed consent form

Study Title: Correlation between lateral trunk flexion and associated risk factors of spine in amateur fast bowlers during front foot landing- An observational study

Study Number: ABS-IEC-2025-PHY-083

Subject 's Name: _____ Subject 's Initials: _____

Date of Birth / Age: _____

Address of the Subject_____ Qualification _____

Occupation: Student/Self-Employed/ Service/Housewife/Others (Please tick as appropriate)

Annual Income of the subject _____if applicable Name and address of the nominee(s) and his relation to the subject

_____(for the purpose of compensation in case of trial related death).]

(i) I confirm that I have read and understood the information sheet dated _____for the above study and have had the opportunity to ask questions.

(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(iii) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)

(iv) I agree to take part in the above study

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

_____

Date: ____/ _____/ _____

Signatory 's Name: _____

Signature of the Investigator:

Date:
Study Investigator ‘s Name: Sumukh N Pandith

Signature of the Witness: _____ Date: _/ _____/ _____
Name of the Witness: _____

ANNEXURE C: Case record form

NAME:

AGE:

GENDER:

HEIGHT:

WEIGHT:

BMI:

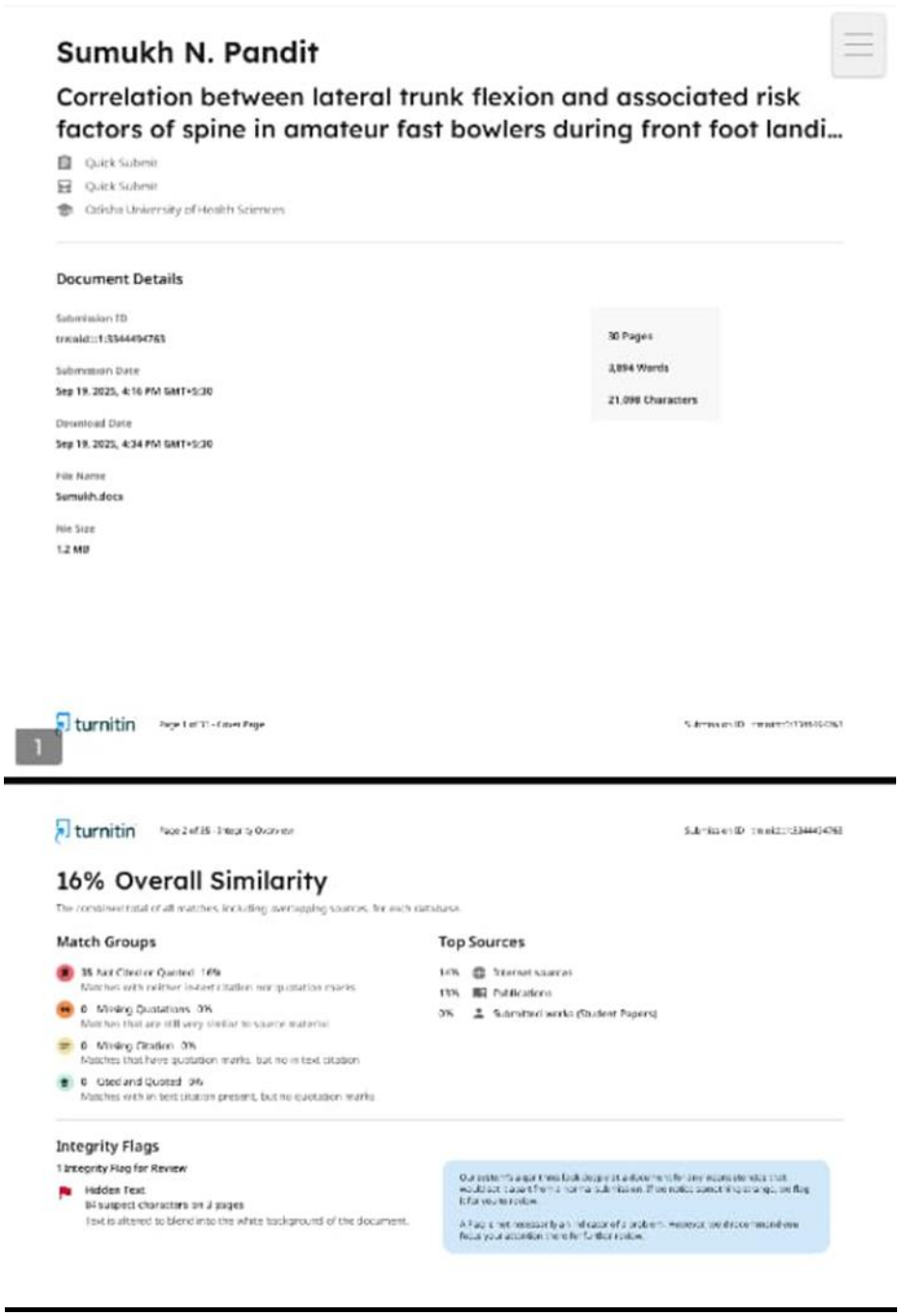
DOMINANT HAND:

OUTCOME	RESULT
1. SPRINT PERFORMANCE	
2. SHOULDER INTERNAL ROTATION	
3. HIP INTERNAL ROTATION	
4. TUNK ROTATION	
5. LATISSIMUS MUSCLE LENGTH	
6. MODIFIED STAR EXCURSION TEST	
7. SINGLE LEG DROP LANDING	
8. LATERAL TRUNK FLEXION	

ANNEXURE D: Master Chart

SL No.	AGE	HEIGHT	WEIGHT	LATISSIMUS LENGTH	SL-LESS	LATERAL TRUNK FLEXION	M-SEBT	SHOULDER IR	HIP IR	TRUNK ROTATION(R)	TRUNK ROTATION(L)	SPRINT(30M DASH)
1	19	173.7	59	170	3	32.8	77.53	71	18	85	88	4.53
2	21	167.6	50	150	2	45.2	82.2	55	20	80	86	4.61
3	18	176.7	59	175	2	23.5	75.9	30	22	75	63	4.53
4	19	173	70	173	2	25.1	100	72	15	82	90	5.08
5	20	168	55	144	2	39.8	87.6	49	21	70	65	4.66
6	25	178	68	178	1	38	82.4	76	28	80	55	5.23
7	25	175	74	149	2	49.8	90.5	43	33	70	90	4.5
8	21	180	64	154	1	46	70	70	40	75	85	4.62
9	21	64	180	155	2	51	72	30	18	88	88	4.66
10	19	66	166	157	2	49	88	31	17	75	86	4.98
11	21	78	178	165	2	50	71	35	20	77	85	5.1
12	22	72	174	172	2	51	75	37	21	74	89	4.67
13	22	64	173	177	2	47	73	33	25	76	90	4.56
14	21	58	170	175	2	46	72	39	19	78	65	4.6
15	19	66	169	158	2	23	78	38	17	73	67	4.71
16	24	78	175	153	2	55	90	47	16	69	78	4.72
17	23	75	179	155	2	51	91	44	15	80	74	4.61
18	22	72	167	164	2	49	79	42	17	90	82	4.66
19	21	68	177	163	1	47	75	34	22	87	75	4.78
20	24	72	180	176	2	44	73	34	25	83	83	4.68
21	25	75	179	177	1	47	95	37	18	78	76	4.79
22	19	72	175	165	2	51	75	31	18	64	74	4.67
23	21	77	172	155	1	51	76	41	15	79	79	4.59
24	20	65	170	153	1	49	79	42	21	84	88	4.76
25	21	59	177	156	1	47	73	43	26	81	72	5.01
26	24	60	178	170	2	48	71	44	17	79	83	4.73
27	25	73	175	157	1	46	80	47	18	88	76	4.9
28	24	72	166	164	1	50	82	38	17	87	88	4.68
29	23	77	162	162	2	49	78	33	21	83	84	4.78
30	23	78	172	161	3	47	83	36	25	73	82	4.76
31	21	57	178	166	2	44	77	42	18	76	84	4.94
32	20	73	173	170	3	42	79	53	17	69	63	4.87
33	20	75	168	166	2	38	81	51	23	78	78	5
34	21	71	179	165	2	39	89	77	20	73	83	5.21
35	22	78	173	163	2	47	94	42	22	85	84	4.78
36	23	68	168	160	2	51	99	62	21	83	66	4.97
37	24	66	173	170	2	55	78	68	25	77	78	4.69
38	20	63	177	172	3	52	73	44	19	68	83	4.79
39	19	71	169	164	1	52	86	31	16	74	70	4.93
40	19	77	172	165	1	51	82	39	19	79	84	4.89
41	25	78	178	158	1	49	75	37	20	86	69	4.68
42	23	73	175	153	1	49	77	35	21	89	82	4.85
43	25	66	173	165	1	51	89	35	22	88	87	4.89
44	22	69	172	164	2	53	91	31	25	85	68	4.67
45	21	73	178	166	2	45	79	33	17	78	82	4.56

ANNEXURE D: Turnitin plagiarism Report



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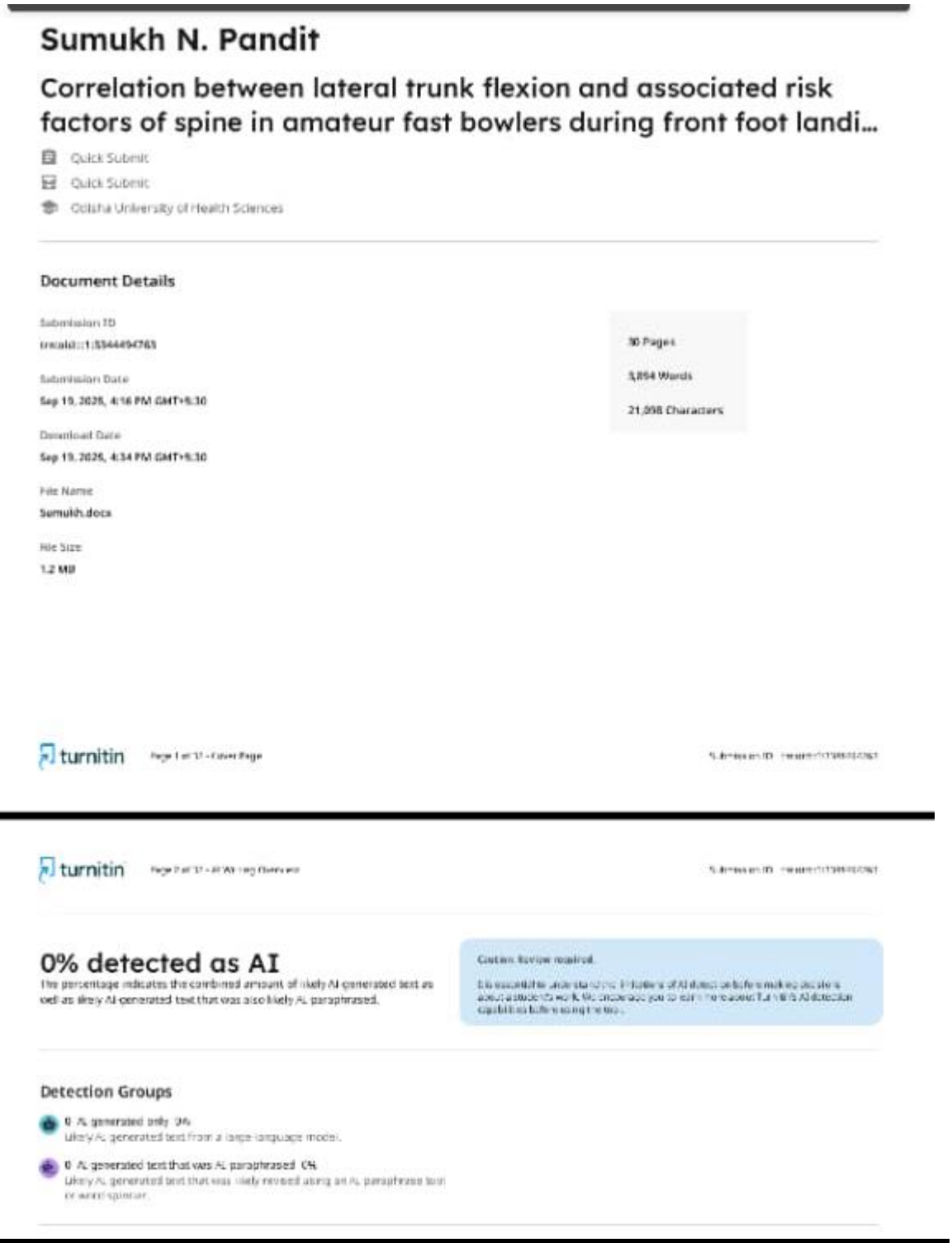

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